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ACCURATE: Influence of Cloud Layers and Aerosol on Infrared Laser Occultation Signals for Sensing of Greenhouse Gases

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ACCURATE (Atmospheric Climate and Chemistry in the UTLS Region And climate Trends Explorer), a new climate satellite concept, enables simultaneous measurement of profiles of greenhouse gases, isotopes, wind and thermodynamic variables from Low Earth Orbit (LEO) satellites. The measurement principle applied is a combination of the novel LEO-LEO infrared laser occultation (LIO) technique and the well-studied but not yet flown LEO-LEO microwave occultation (LMO) technique. As intrinsic to the space-borne occultation technique, the measurements are evenly distributed around the world, have high vertical resolution and high accuracy and are stable over long time periods.

The LIO uses near-monochromatic signals in the short-wave infrared range ($\sim$2-2.5 μm in the case of ACCURATE) which are absorbed by various trace species in the Earth's atmosphere. From signal transmission measurements, profiles of the concentration of the absorbing species can be derived given that temperature and pressure are accurately known from LMO. The current ACCURATE mission design is arranged for the measurement of six greenhouse gases (H_2O, CO_2, CH_4, N_2O, O_3, CO) and four isotopes ($^{13}CO_2$, $C^{18}OO$, HDO, $H_2^{18}O$) with focus on the upper troposphere/lower stratosphere region (UTLS, 5-35 km). Wind speed in line-of-sight can be derived from a line-symmetric transmission difference which is caused by wind-induced Doppler shift. By-products are information on cloud layering, aerosol extinction and scintillation strength.

This contribution presents an overview on the ACCURATE mission design and the expected accuracy of retrieved atmospheric variables and further focuses on the influence of clouds and aerosols on propagating LIO signals. Special emphasis will be given to sub-visible cirrus clouds which are semi-transparent to infrared signals. A simple frequency dependent cloud extinction parametrization was included into the occultation propagation software EGOPS and evaluated against results of the advanced radiative transfer model libRadtran. Use of this parametrization also allows to separate the disturbance by clouds from other atmospheric influences on signal transmission. The influence of aerosols was investigated by means of an extinction model developed on the basis of SAGE (Stratospheric Aerosol and Gas Experiment) measurements. The effects of different cases from background to volcanic aerosol levels are presented.